AdFaM

Advanced **Fa**tigue **M**ethodologies to optimize fatigue assessment of critical components

OBJECTIVES

An improved understanding of fatigue endurance and of underlying mechanisms is relevant both for long term operation of operating plants as well as for new plants. It is expected that the inclusion of both stabilized and non-stabilized austenitic stainless steels and utilizing a mechanistic approach will enable the findings to benefit both Gen II and Gen III light-water reactors. The expected outcome of this joint R&D project (launched in 2014) of European research laboratories, vendors and plant operators has been the confirmation of the positive effects due to service loading, mapping of mechanisms responsible for grade specific and generic improvements, providing an important step towards optimized fatigue assessment of critical components. Due to the proposed integration of European R&D facilities performing material testing, a harmonized testing procedure is performed in accordance with the necessity of comparability of results.

DESCRIPTION OF WORK

In particular, AdFaM has focused on an empirical and mechanistic investigation of the effects of hold times on fatigue life. A small number of previous test results suggest an increase in fatigue life for stabilized grades of austenitic stainless steel when hold times (ranging from several hours to days) are introduced into a test between periods of strain-controlled cyclic loading. Tests incorporating hold times may be more representative of material behavior in NPPs, where temperature transients due to start-ups, shutdowns and major power changes may be separated by long periods of steady state operation.

Under AdFaM, fatigue endurance tests incorporating hold times have been completed on stabilized and non-stabilized stainless steel grades (Types 304L and 347) and the mechanisms responsible for the observed variations in fatigue life have been investigated using a range of microscopy techniques.

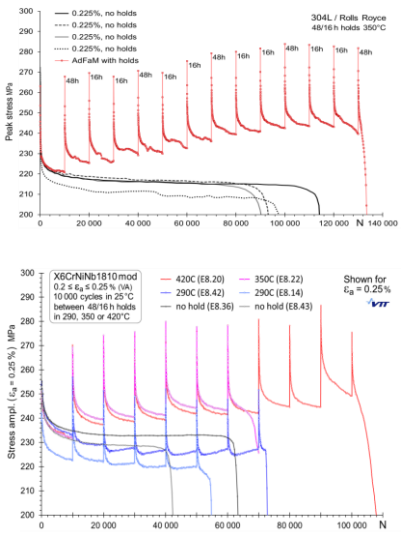

Fig. 1 – Hold time effect for both stabilized and non-stabilized stainless steels

MAIN RESULTS / HIGHLIGHTS

Results confirm a significant extension of fatigue life due to hold times in both stabilized and non-stabilized grades. Life extension appears to be linked to hold hardening observed in cyclic behavior, and this link has been investigated through microstructural characterization of fatigue specimens examined before and after holding at elevated temperature.

This project helps to improve the understanding of transferability of results from small specimen tests (without hold times) to analysis of NPP components and provides insights that will contribute towards continuing development of fatigue design curves and analysis methods in Design Codes such as ASME Code Section III and KTA 3201/3211.

The AdFaM project is now complete. The valuable results and insights gained from this work demonstrate the significant benefits of collaborative research between various industrial and academic partners in the area of fatigue of NPP materials.

DURATION

1st of February 2014 – 31st of July 2016
2,5 years

PARTNERS

E.ON Kernkraft GmbH, Rolls-Royce plc,
VTT – Technical research Center of Finland,
Areva GmbH, The University of Manchester

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